Sustainable procurement performance of large enterprises across supply chain tiers and geographic regions

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Abstract:

Sustainable procurement is steering today's supply chains towards responsible business practices. This research aims to examine the trend in the sustainability performance of large enterprises for supplier selection across supply chain tiers and geographic locations. Secondary data on 83 global, large enterprises discussing sustainable procurement practices are analysed using hierarchical multiple regression analysis. Dynamic capabilities view and stakeholder theory are utilised to develop the hypotheses. The results show that sustainable procurement performance for large enterprises varies across supply chain tiers and increases in the direction of the end-customer. Due to standardisation of regulations and dynamic capabilities of global, large enterprises, no significant difference is observed across geographic regions.

Keywords: Sustainable procurement, Supplier selection, Large enterprises, Regression analysis, Multi-tier supply chains, Dynamic capabilities view, Stakeholder theory

1. Introduction

Growing sustainability requirements are driving several organisations to develop policies and practices that extend beyond organisational boundaries (Meehan and Bryde 2011). More recently, procurement function has focussed attention on sustainability along with other criteria such as cost, lead time, flexibility and exposure to risk (Walker and Brammer 2009; Ghadimi et al. 2016). With a rising trend towards outsourcing and sustainability, the supplier selection process is a significant contributor towards meeting the strategic objectives of the business.

Sustainable procurement is a relatively recent agenda for academics as well as practitioners (Walker et al. 2012; Genovese et al. 2014; Zimmer et al. 2016). There has been increasing public awareness regarding environmental and social issues, thereby encouraging organisations to implement sustainable practices in their operations. Procurement practitioners are expected to ethically source products and services that are economically viable and have a minimal environmental impact (Kaye Nijaki and Worrel 2012; Pagell and Shevchenko 2014; Sarkis and Zhu 2017). Furthermore, the procurement process needs to be compliant with set regulations and stakeholders' expectations (Shaik and Abdul-Kader 2011; Reuter et al. 2012).

To maintain a competitive advantage, buyer-supplier relationship and supplier selection process are regarded as critical during procurement (Chen et al. 2006; Ghadge et al. 2017). However, the offshoring and globalisation trend has made the process challenging. A typical supplier selection process involves identifying needs and specifications, formulation of criteria, qualification reassessment and final evaluation (Driedonks 2010). However, supplier engagement can vary based on level and location in the global supply chain network. Suppliers operating in business-to-business settings may not be under direct scrutiny from end consumers. Upstream suppliers could be, therefore, exploiting their distance and position (tier level) in the network only to satisfy minimum sustainability obligations (Siegel 2009). Moreover, sustainability-related views are relative and could differ with respect to the organisations, sectors, cultures and countries (Walker and Phillips 2008). Due to these differences combined with regional government regulations, benchmarking sustainability standards is extremely difficult in Supply Chain (SC) Management (Trienekens and Zuurbier 2008). The lack of research explaining such differences in the supplier selection process is evident in the research (e.g. Igarashi et al. 2013; Govindan et al. 2015). Additionally, there is apparent research limitation on understanding sustainable procurement through different theoretical lenses (Hoejmose and Adrien-Kirby 2012; Touboulic and Walker 2015). Appropriate theoretical views could help in developing conceptual frameworks for a better understanding of the sustainable procurement field. These evident research gaps raise a fundamental research question: *What trend exists for sustainability performance in procurement across supply chain stakeholders and geographic locations?*

This exploratory study attempts to answer the research question in the context of large enterprises following a literature survey and secondary data on sustainable procurement criteria collected from 83 global organisations. Small and Medium Enterprises (SMEs) with a strong buyer-supplier relationship and global presence is limited due to their restricted opportunities for communication, collaboration and control (Grey et al. 2017). Hence the focus was placed on large enterprises. The large enterprises based in Europe and the Americas (north and south), are termed as '*large western companies*'. Similarly, larger enterprises based in Africa, Asia and Australia are grouped as '*large eastern companies*'. According to the EU recommendation 2003/361, Large enterprises/companies have an annual turnover over Euro 50 million and has more than 250 employees (European Commission 2009). Through this focused study, the research endeavours to build a robust understanding of sustainability performance across two locations (western and eastern) and at different stages in the supply chain tiers.

A literature review (section 2) on sustainable procurement and unified theories guides in developing three hypotheses. The secondary data detailing sustainable supplier selection criteria for global, large enterprises are used to test these hypotheses. Data are analysed using multiple regression and hierarchical multiple regression approaches. Section 3 focusses on research methodology, and section 4 provides a comprehensive analysis of the data. Section 5 summarises the key findings, (theoretical and practical) implications, limitations and areas for future research.

2. Literature Review

2.1 Theoretical background

Applied disciplines such as operations and supply chain management often lack a firm theoretical basis due to the focus on addressing practical problems (Walker et al. 2015). Sustainable supplier selection is unlike traditional supplier selection theory, which refers to the resource-based view, make or buy, agency theory, etc. Literature reviews by Seuring and Muller (2008), Igarashi et al. (2013), Touboulic and Walker (2015) and Wilhelm et al. (2016) document that there is little research on the theory associated with sustainable supplier selection. Furthermore, a thorough literature review of existing theories that are hypothesised towards sustainable supplier selection demonstrates that no set theory or portfolio is being used to select sustainable suppliers. The next section attempts to shape a theoretical background for sustainable supplier selection. The identified theories support building the hypotheses for study.

2.1.1 Stakeholder Theory

According to Carter and Easton (2011), one of the most prevalent theories related to sustainability is Stakeholder Theory. Stakeholders are defined as "*those groups and individuals who can affect or be affected by the creation of value and trade of business*" (Freeman et al. 2010). There are various forms of stakeholder theory mentioned in the academic literature discussing stakeholder relationship management (Verbeke and Tung 2013). Instrumental stakeholder theory, descriptive stakeholder theory, normative stakeholder theory and integrative stakeholder theory are a few of the types of stakeholder theory (Hörisch et al. 2014). Freeman's stakeholder theory (1994) is often wrongly criticised for not treating all the stakeholders equally. On the contrary, this is justified as not all stakeholders are equally

involved in the business. The theory is related to harvesting mutual interests while creating value for all the stakeholders involved, rather than mere trade-offs with profit and short-term gains. Trade-offs and compromise are an integral part of the business and more so in the context of sustainability (Beckmann et al. 2014). This is particularly relevant to the weighting of sustainable factors and avoiding a trade-off attitude towards reducing carbon emission for financial gains. Stakeholder theory postulates that the social and environmental aspects should not be overshadowed by short-term gains (Freeman et al. 2010). Business ethics, environmental and social considerations are core to business stakeholders and should not be separated (Loorbach and Wijsman 2013). Extensive academic literature re-iterates that profits are not an opposing factor to environmental and social aspects, but work together to create viable long-term solutions, considering all stakeholders; thus fulfilling sustainability requirements. The core concept of stakeholder theory is meeting all stakeholders' expectations and working towards creating value for all involved. Therefore, stakeholder theory implies that, in the complex supply chain network, stakeholder involvement is expected to vary. This leads us to develop our first hypothesis.

H1: Each stakeholder in the SC network has different sustainability performance.

As with most theories, stakeholder theory is not without its limitations. There can be issues with linking sustainability to stakeholder theory since sustainability management defines the differences between the social, environmental and economic more definitively than the stakeholder theory (Klettner et al. 2014). It can be challenging to include the natural world (i.e., environment) as a stakeholder (Carroll and Buchholtz 2014). This usually means there needs to be an agent or body who represents the natural world element. It can also be a time-consuming task to integrate and implement sustainable dimensions into other stakeholders (Starik and Kanashiro 2013). However, these difficulties can be overcome by use of regulations and generating awareness among stakeholders.

2.1.2 Dynamic Capabilities View

The Dynamic Capabilities View (DCV) is derived from the resource-based view (RBV) theory. As discussed by Barney (2001), the RBV of the firm suggests that companies gain competitive advantage from the resources and capabilities that they have. The DCV goes a step further, whereby a company can purposefully gain a competitive advantage by conducting faster change than its competitors (Eisenhardt and Martin 2000). This generates the ability to develop and launch new strategies and operational resources to respond to changes or challenges in the

competitive environment (Helfat et al. 2007). The growth in globalisation and selecting suppliers emphasises the need for companies to be able to quickly adapt to changes in stakeholder commitments, environmental criteria and global legislation (Walker et al. 2008).

Organisations can reduce supply chain risk and improve competitive advantage by adopting sustainable practices (Ghadge et al. 2012). The selection of appropriate sustainable suppliers should avoid any detrimental effects on an organisation's reputation. This, in turn, allows the selected suppliers to develop their environmental, ecological and social performance measures. This will reduce any environmental or social disasters, non-compliance and unwanted media attention (Eisenhardt and Martin 2000; Campbell 2007). Companies that evaluate environmental and social factors in the supplier selection process gain competitive advantage (Reuter et al. 2010). This is because they could build upon previously found knowledge to develop performance indicators and build contingency plans for any non-compliance. This not only leads to the ability to react faster to stakeholder pressure and disasters but also improves overall operational performance. The most competitive aspect of DCV is the speed of response. To fulfil dynamic capabilities of changing markets, companies must be fully aware of external dynamics (Campbell 2007). This can be best achieved by the external integration of resources and cooperation. The DCV impacts the sustainability performance based on risk mitigation and other competitive strategies adopted by the companies. The DCV-based theory leads to the development of a hypothesis related to the differences in the sustainable performance based on a stakeholder's competitive behaviour and position within the business.

H2: There exists a difference in the sustainability performance of large eastern and large western companies.

2.2. Sustainable Procurement

The ever-increasing burden placed upon limited resources and the considerable environmental concerns have prompted companies to incorporate sustainable practices into their supply chain networks. Different stakeholders such as regulators, end consumers and NGOs provide added pressure to sustainable business practices (Foerstl et al. 2015). This increased pressure has prompted companies to develop policies and practices in relation to their procurement activities. Cost reduction through green practices is the most significant internal factor motivating organisations to join sustainable procurement initiatives (Walker et al. 2012). Environmental procurement lowers operational cost through the reuse of assets (Erkul et al.

2015). Support from top management for advanced technology and environmental innovation is the most influential driver for sustainable procurement (Giunipero et al. 2012). Corporate infrastructures such as an environmental management system and pollution control system need consistent and robust support from the top management (Walker et al. 2012). Critical environmental crises such as climate change, waste disposal and natural resource depletion are driving environmental procurement concerns (Walker et al. 2008). One of the significant hindrances to the adaptation of sustainable/green procurement practices is investment cost (Giunipero et al. 2012). Upgrades to energy-efficient machines and improved remanufacturing systems need high investment which is difficult to manage for small firms (Vachon and Klassen 2008). Another obstacle that has been emphasised is the lack of clear standards and appropriate regulations set by the regulatory bodies (Sarkis and Dhavale 2015). Regarding regulations, each region in the world may have different acceptable standards (Zhu and Sarkis 2006). The successful inception of sustainable procurement practices could not be accomplished by the individual organisation but by the entire supply chain network.

Some of the seminal work on supplier selection has identified five main selection criteria namely, price, quality, lead time, service and delivery (Wilson 1994). Dickson (1966) identifies twenty-three supplier selection criteria which have been widely used in the academic literature. Over the past years, abundant research has been presented on supplier selection criteria and evaluation (Ellram 1990; Stamm and Golhar 1993; Govindan et al. 2015). It is interesting to observe that all of the identified criteria paid little or no attention to environmental and social considerations during the early stages. According to Dowlatshahi (2000), the first green procurement initiatives started to appear close to the 1990s. The term "green" refers to one of the three aspects of the sustainability, also known as the '*triple bottom line*' (Carter and Rogers 2008). Ensuring all three aspects of sustainability are being considered in the supplier selection itself is a difficult task (Bai and Sarkis 2010). However, there is evident academic literature to support the enhancement of sustainability within the procurement function.

2.2.1. Challenges to implementing sustainable procurement

Difficulties associated with the institutionalisation of the business routine, introducing new processes and building new relationships with different suppliers, can be challenging to interpret (Meehan and Bryde 2011). The change can be promoted through continuous supplier assessment, complemented by internal and external knowledge exchange. Lack of transparency, reliability of data and customer support are some of the issues driven by the

global cultural differences (Jim Wu et al. 2013). Organisations operating in countries where there are no stringent sustainable criteria are believed to be poor in the sustainable practices. Increased geographic supply chain diversity is experienced with an increase in the outsourced activities (Stonebraker et al. 2009). The perception of ethical standards across different countries is diverse (Cooper et al. 2000). Asian companies are regarded as one of the global contributors to raw materials and sub-assembled products and supplies (Sturgeon and Lester 2004). Western companies based in Europe and America using outsourced manufacturing in Asia will need to stipulate greater compliance to sustainable awareness in order to fulfil the increasing expectations of their customers (Genovese et al. 2013). The ever-increasing contribution of academic research on the topic of sustainable procurement from Taiwan, China and India demonstrate the newfound interest and challenges being faced by eastern companies. Attention also needs to be paid to the proximity of the company to the final customer in the supply chain. Nawrocka (2008) suggests that the position of the company in the supply chain will distinguish the leverage that can or cannot be realised in sustainable procurement. Thus, large companies will exert pressure on upstream tiers in the supply chain in order to specify more detailed sustainable criteria in the selection process. This leads us to the following hypothesis.

H3: The stakeholder closest to the end customer has the most comprehensive sustainability performance.

Following the above theoretical perspectives and literature on sustainable procurement, three hypotheses are proposed for this study. The next section on research methodology discusses the approaches followed to test the hypotheses.

3. Research Methodology

Several quantitative research methods have been used to study sustainability and procurement-related problems. Analytical Hierarchy Process (AHP), Analytic Network Process (ANP), Fuzzy Logic, Data Envelope Analysis (DEA) or a combination of more than one can be used to help as a decision tool for the sustainable supplier selection. Table 1 shows some of the mathematical, analytical decision tools being used to address widespread problems in sustainable procurement.

Table 1. Research methods adopted for sustainable procurement

Author(s)	Journal name	Research method
Awashti et al. 2010	Journal of Production Economics	Fuzzy Logic
Bai and Sarkis 2010	Journal of Production Economics	Grey System and Rough Set Theory
Bai et al. 2010	Management Research Review	Rough Set Theory
Büyüközkan and Çifçi 2011	International Journal of Production Research	Fuzzy Logic
Che 2010	International Journal of Production Research	Fuzzy AHP with Particle Swarm Optimisation
Handfield et al. 2002	Journal of Operational Research	AHP
Hsu and Hu 2009	Journal of Cleaner Production	ANP
Humphreys et al. 2006	International Journal of Production Research	Fuzzy Logic
Kannan et al. 2008	International Journal of Decision Making	Interpretive Structural Modelling and AHP
Kuo and Lin 2011	International Journal of Production Research	ANP and DEA
Kuo et al. 2010	International Journal of Cleaner Production	Artificial Neural Network and Multi Attribute Decision Analysis
Lu et al. 2007	International Journal of Production Research	Multi Objective Decision Analysis
Mafakheri et al. 2011	International Journal of Production Economics	Dynamic Programming
Tsai and Hung 2009	International Journal of Production Research	Fuzzy Logic
Tseng and Chiu 2013	International Journal of Cleaner Production	Linguistic Preferences
Yeh and Chuang 2011	Expert Systems with Applications	Multi Objective Genetic Algorithm for Partner Selection

The most prominent mathematical, analytical tools employed have been Fuzzy logic, ANP and DEA (Table 1). The limitation with some of the previously mentioned mathematical, analytical multi-criteria decision tools is generally associated with depth of data required and transparency of the modelling process (Ishizaka and Nemery 2013). Based on previous analytical methods used for the supplier selection process, there is an evident lack of research using any form of regression analysis. The paper is the first to apply regression analysis to test the hypotheses in order to predict trends in sustainable procurement.

3.1 Data collection

The empirical research follows a deductive approach to investigate the different trends in sustainable procurement for large enterprises. In the first stage, an extensive literature review was conducted to identify the environmental and social criteria used for assessing sustainable procurement performance. Understanding regarding commonly adapted research methods was also developed through the literature survey. In the second stage, secondary data from 83 large, well established global manufacturing and technology companies were collected to test the proposed hypotheses. Secondary data are permanent in nature compared to primary data and readily available for public scrutiny (Denscombe 2014). The data consisted of companies' sustainable procurement guidelines and policies for suppliers/stakeholders. Following European Commission's (2009) defined range for turnover and number of employees, only large enterprises were identified for the study. A list of 120 large manufacturing and technology companies at different positions in the supply chain and different geographic locations were prepared. Later, search terms such as *"[company name] sustainable supplier criteria/policy/guidelines*" were used in various online search engines (e.g., Google, Bing and Yahoo) to collect the necessary information. Several companies make this information accessible when they are interested in promoting sustainable practices. From the list of those 120 global companies, 54 large enterprises provided their sustainable procurement guidelines public on their corporate website. The most recent reports for those companies were assessed directly. For the remaining 66 large enterprises (with lack of access to online documents), the necessary information had to be requested from their public relation departments. Relevant departments/functions were contacted through email and LinkedIn (professional business network), seeking their sustainable procurement/supplier guidelines. However, only 29 companies responded and were able to provide recent and accurate information following a rigorous sequel of interactions. In total, 83 large-sized company reports on sustainable procurement guidelines were collated and utilised for the next stage of assessment. Since the

sustainability reports were either available online or supplied by the companies, this approach strengthened data validity and made the assessment process robust. Figure 1(a) and Figure 1(b) show the distribution of companies, year-wise and region-wide, respectively.

Figure 1(a). Year wise distribution

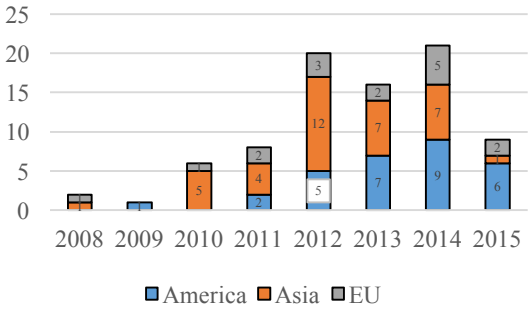

Figure 1(b). Region wise distribution

The distribution shows that most of these large enterprises have multiple stakeholders in the supply network from raw material producers (tier 4), parts manufacturers (tier 3), parts assembly and infrastructure developers (tier 2) to final product distributors (tier 1). Large eastern and western companies are classified by global location of selected company's primary

Table 2. Environmental and social criteria from academic literature

Type	Category	Criteria	References
Environmental Criteria	Procurement Management	Green image/mission and requirement for green purchasing	(Tuzkaya et al. 2009); (Min and Galle 1997); (Humphreys et al. 2003); (Lamming 1996);(Yuang and Kielkiewicz-Yuang 2001); (Zhu et al. 2005).
	Procurement Management	Availability and coding of clean green materials	(Min and Galle 1997); (Lee 2008); (Walton et al. 1998) (Eveloy et al. 2005); (Handfield et al. 2002).
	Procurement Management	Supplier management	(Handfield et al. 2002); (Zhu and Geng 2001).
	Environmental Performance	Environmental efficiency/pollution control and waste management	(Noci 1997); (Tuzkaya et al. 2009); (Min and Galle 1997); (Lee 2008); (Handfield et al. 2002); (Humphreys et al. 2003).
	Environemental Performance	Green product	(Tuzkaya et al. 2009); (Lee 2008); (Handfield et al. 2002)

	Environmental Performance	Environmental programs	(Handfield et al. 2002).
	Research and Development	Net life cycle cost/environmental costs	(Noci 1997); (Tuzkaya et al. 2009); Min and Galle (1997); (Humphreys et al. 2003)
	Research and Development	Legal-compliance competency/environmental regulation	(Huang and Keskar 2007); (Min and Galle 1997); (Handfield et al. 2002).
	Research and Development	Environmental partnership with suppliers	(Min and Galle 1997).
	Reserch and Development	Design for environment/capability of green design	(Handfield et al. 2002); (Humphrey et al. 2003); (Yuang and Kielkiewicz-Yuang 2001); (Zhu et al. 2005).
	Environmental Practices	Environmental and legislative management (EMS)	(Tuzkaya et al. 2009); (Lee 2008); (Humphreys et al. 2003); (Zhu and Geng 2001); (Handfield et al. 2002).
	Process Management	Process auditing/inspections /quality control	(Handfield et al. 2002); (Zsidisin and Siferd 2001).
	Process Management	Green process management	(Tuzkaya et al. 2009); (Lee 2008); (Humphreys et al. 2003).
	Process Management	Packaging, reverse logistics	(Handfield et al. 2002); (Walton et al. 2006).
	Management System	Quality management system	(Huang and Keskar 2007).
	Management Systems	Management competencies	(Humphreys et al. 2003).
	Management System	Inventory and management of hazardous substances	(Handfield et al. 2002); (Zhu and Geng 2001).
Social criteria	Internal	Employment Practices	(Gauthier 2005); (Presley et al. 2007); (Labuschagne et al. 2005).
		Health and Safety	
	External	Local community influence	
		Contractual stakeholders' influence	
		Other stakeholders influence	

operations. Table 2 shows the list of identified environmental and social criteria derived from the academic literature. Keywords such as *social, green, environmental, economic, sustainability* were used together with *supplier selection, supplier evaluation and sustainable procurement* phrases to identify suitable academic sources. Only journal publications meeting inclusion criteria were screened following a careful reading of abstracts. All other sources such as conference papers, textbooks and other non-referred sources were excluded from the screening process. The final selection comprised of 78 journal papers discussing various sustainability criteria for supplier selection. The data were then synthesised into different categories and criteria as seen in Table 2.

Table 3 shows the identified sustainability criteria from various documents collected for the selected companies. Key themes and strings were identified and classified by carefully reading each document. The literature review supported the identification of key themes and strings for screening the secondary data. A total of 43 environmental criteria and 19 social criteria were identified following a data mining exercise. Each identified sustainability criterion was again checked across all the documents to assess its importance for supplier selection.

Table 3. Environmental and Social criteria from selected company data

Identified environmental criteria	Identified social criteria
EMS with ISO 14001	Local conservation projects
Audits / environmental quality management system	Human dignity
Management commitment	Equal opportunities
Environmental policy /conservation	No discrimination
Compliance with laws and regulations	Protecting indigenous rights
Staff in charge of EMS function	Adequate social conditions
Staff training	Ban on arbitrary personnel measures
Management of harmful substances/recording and reporting	Fair wages for living
REACH or equivalent	Responsible action
Use of recycled plastic and parts	Health and safety
Use of recycled paper	Respect for People
Energy saving features for equipment/equipment purchase	Social contribution/Philanthropy
Staff uniform made of recyclables	Local suppliers
Energy efficient lighting	Human rights
Waste reduction	Use local suppliers and contractors
Reduction of VOC	Socio economic assessments
CO2 reduction and monitoring	Working with communities

Water consumption and reduction	Child labour
Water for disposal/pollution	No forced working/exploitation
Monitoring total energy consumption	
Life Cycle assessment	Local conservation projects
Comprehensive material markings/disclosure and traceability	Human dignity
Least possible burden on environment	Equal opportunities
Packaging reduction/ recycling	No discrimination
Packaging material list/reduction	Local conservation projects
Prevent soil and ground water damage	Human dignity
Raw materials/natural resources	Protecting indigenous rights
3rd party contractors	Adequate social conditions
Design for environment	Ban on arbitrary personnel measures
Transport measures /reduction in emissions/mode	Fair wages for living
Energy consumption reduction	Responsible action
End of life treatment and recycling/site closure	Health and safety
Promoting Biodiversity/Ecology awareness	Respect for People
Treatment of waste	Social contribution/Philanthropy
Reduce air pollution	Local suppliers
Improve fuel economy	Human rights
Environmental risk management	Use local suppliers and contractors
information sharing/partnerships	Socio economic assessments
Carbon foot printing	Child labour
Using recyclable/renewable materials	No forced working/exploitation

Table 4 shows the categorisation and average percentage of each criterion across the four supply tiers and two locations. It can be observed that environmental regulations, green purchasing and sustainable product quality are the leading selection criteria for today's companies.

Table 4. Consolidated criteria results

Consolidated Criteria	Total %	Tier 4	Tier 3	Tier 2	Tier 1	Asia	Europe/USA
ENVIRONMENTAL Criteria							
Environmental regulations							
EMS with ISO 14001 or equivalent	86	66	100	100	100	88	80
Environmental and Legislative management	61	66	50	60	77	60	60
Process Management							
Process Auditing/ Inspections /Control	52	100	50	60	55	48	60
Management competencies	8	33	33	0	0	4	20
Environmentally friendly product packaging and reduction	33	0	33	60	38	28	10
Procurement Management							

Green image/mission and requirement for green purchasing	55	100	66	100	44	60	40
Supplier management/Green supplier selection	14	0	0	40	27	12	40
Environmental Risk management	8	66	0	20	0	4	20
Management Systems							
Environmental staff training and involvement	50	33	50	40	66	52	80
Hazardous substance mgmt. system/REACH or equivalent	66	33	100	80	72	88	90
Toxic waste pollution management	14	33	0	20	16	8	30
Environmental Performance							
Use of green materials in production process	8	0	0	20	11	12	50
Percentage of recycled waste	0	0	0	0	0	0	0
Energy efficiency and resource consumption	52	100	50	80	50	64	70
Ozone depleting substances	11	33	0	0	16	12	10
Air-emission level	33	66	0	20	50	40	40
Pollution control and waste management	50	100	33	60	55	48	60
Public disclosure of environmental record	61	33	50	60	83	56	80
Second tier suppliers evaluation	8	0	0	0	16	4	20
Use of renewable and recycled materials	20	66	16	0	16	8	0
Research and Development							
Green design capability	31	0	16	80	33	36	20
Life Cycle costs/environmental costs	25	33	16	20	33	20	40
Biodiversity	25	66	16	20	27	20	40
Environmental supplier partnerships	11	100	16	0	16	16	20
SOCIAL Criteria							
Internal							
Employment practices	27	10	16	20	22	4	30
Employee contracts	0	0	0	0	0	0	0
Equity labour sources	3	33	0	0	6	0	20
diversity	0	0	0	0	6	0	30
flexible working arrangements	0	0	0	0	0	0	10
Job opportunities	6	2	0	0	0	0	10
Employment compensation	0	0	0	0	6	0	10
Discrimination	7	10	0	20	6	0	30
Research and development	0	0	0	0	0	0	0
Health and Safety	7	10	0	20	6	0	30
HS practices and incidents	0	0	0	0	0	0	0
External							
Local community influence	17	66	0	0	17	0	0
Health	6	0	0	0	0	0	30
Education	0	0	0	0	6	0	0
Housing	5	6	0	0	6	0	20
Service infrastructure	0	0	0	0	0	0	0
Mobility infrastructure	3	0	0	0	0	0	10
Regulatory and public service	0	0	0	0	0	0	0
Supporting educational institutions	3	0	0	0	0	4	10
Security	0	0	0	0	0	0	0
Cultural properties	6	66	0	0	0	0	20
Social cohesion	3	0	0	0	6	0	20
Social pathologies	0	0	0	0	0	0	0
Grants and donations	6	33	0	0	6	4	0
supporting community projects	3	33	0	0	6	4	10
Contractual Stakeholder Influence							
Procurement standard	0	0	0	0	0	0	0
Partnership screens and standards	0	0	0	0	0	0	0
consumer education	0	0	0	0	0	0	0
Other stakeholder engagement							
Stakeholder engagement	3	0	0	0	0	0	10

3.2 Multiple Correlation and Regression Analysis

Multiple linear regression requires a set of variables for the analysis. The dependent variables (or the observed outcome variable) are the criteria that were collected from the literature review. The independent variables were drawn from the secondary data collected on sustainable procurement policies across the companies. A multiple correlation and regression analysis were conducted on four independent variables to demonstrate trends and statistical significance. The process was repeated by controlling for location: large western and eastern companies. Thus, the two controlling independent variables were geographic locations. A hierarchical correlation analysis was conducted to determine the contribution to the supply tiers in relation to the geographic location. Finally, a regression equation model was derived predicting the relationships between the different supply chain tiers and geographic locations. The SPSS software was used to run multiple correlation and regression analysis.

4. Data Analysis

Average total criteria were set as a dependent variable, and the four tiers were set as the independent predictor variables. A hierarchical multiple regression analysis was used for testing the first and second hypotheses relating to tiers and two locations respectively. The input data were checked for any multi-collinearity, singularity, independence of the residuals and any outliers. Table 5 shows the values of different correlation coefficients and multicollinearity statistics to ensure the validity of the regression analysis.

Table 5. Table for assumptions checking

Pearson R	Durbin Watson	Model 1	Collinearity Statistics		Pearson Correlation Matrix				
0.995	2.118		Tolerance	VIF		Total criteria	Tier 4	Tier 3	Tier 2	Tier 1
		(Constant)			Total criteria	1.000	0.528	0.919	0.907	0.975
		Tier 4	0.799	1.251	Tier 4	0.528	1.000	0.408	0.429	0.433
		Tier 3	0.205	4.880	Tier 3	0.919	0.408	1.000	0.851	0.866
		Tier 2	0.218	4.593	Tier 2	0.907	0.429	0.851	1.000	0.855
		Tier 1	0.196	5.090	Tier 1	0.975	0.433	0.866	.855	1.000

The Pearson R-value was used to determine the tolerance in the collinearity statistics. The R-value was less than 1 (=0.995) indicating no singularity. Singularity is when the independent variables are perfectly correlated (Draper and Smith, 2014). The Durbin Watson

value was also used for checking independence of the residuals over time; the value was 2.118, slightly above 2 (the value for zero autocorrelation) and, hence, the null hypothesis of no auto-correlation cannot be rejected at the 5% significance level. The Pearson Correlation Matrix was used to show the extent of collinearity. Multi-collinearity is when two or more of the independent variables are (almost) perfectly correlated and would make regression analysis invalid (Draper and Smith, 2014). The analysis results in Table 5 met most of the assumptions of independence of residuals, singularity, collinearity and outliers in the data. The values confirm that no corrective actions were needed before continuing with the regression analysis.

A multiple linear regression equation model was built for four supply tiers. A dummy variable for one of the two locations was added later in a hierarchical multiple regression model. The paper does not discuss the development of the regression model in detail as it is beyond the scope of the study. However, the regression model met all the assumptions mentioned previously and was robust for the next level of analysis. Hierarchical multiple regression was used to make a prediction based on the variables that can be controlled to observe the level of influence on the full model.

The key findings of the analysis are summarised in Table 6 representing the correlation between all independent variables and the dependent variables. It can be observed that all the values are significant contributors as the P or significance values are all less than 0.05.

Table 6. Correlation Matrix with all variables

Pearson Correlation	Total criteria	Large Eastern	Large Western	Tier 4	Tier 3	Tier 2	Tier 1
(1 Tailed) N =							
Total criteria	1						
Eastern	0.627	1					
Western	0.447	0.999	1				
Tier 4	0.478	0.348	0.372	1			
Tier 3	0.918	0.593	0.385	0.372	1		
Tier 2	0.902	0.565	0.381	0.385	0.844	1	
Tier 1	0.974	0.619	0.428	0.381	0.861	0.847	1

Table 7 summarises the findings related to different correlations. It is observed that total criteria correlation increases further down the supply chain tiers, as they get closer to the

final customers (Tier 1). However, the correlation is less across the two locations than that of the total criteria. This supports hypotheses H1 and H3, that the sustainable procurement criterion varies across the tiers and tends to increase closer to the final customer for large companies. Tier 1 (p=0.974) and tier 4 (P=0.478) correlation values suggest that hypothesis H1 is well supported by the data and should not be rejected. The marginal difference between tier 2 and tier 3 could be associated with the integrated nature of operations with very little differentiation in terms of the services provided by the respective tiers. Table 7 also presents the correlations between four tiers and two locations. Tier 4 shows a very marginal difference in correlation with respect to two locations. Although Tier 1 suppliers show a higher correlation with large eastern companies compared to large western companies, there is no significant relationship between the two locations across all supply chain tiers for large enterprises.

Table 7. Consolidated correlation findings

Tier	Total Criteria	Large eastern companies	Large western companies
4	Has the least correlation to total criteria indicating that tier 4 suppliers have the least impact on the total criteria (0.478).	Tier 4 again has least correlation to the Eastern location (0.348).	Tier 4 has the least correlation to western location (0.372); but slightly higher than eastern location.
3	Has higher value than that of tier 4 suppliers, indicating that there is a noticeable difference between tier 4 and tier 3 (0.918).	Correlation increases to 0.593.	Correlation increases to 0.385 but lower than eastern location.
2	Marginally less than tier 3 and less than tier 1 (0.902).	Correlation falls marginally to 0.565.	Correlation falls marginally to 0.381.
1	This has the highest and significant correlation to total criteria indicating that this correlates most significantly to the total criteria (0.974).	Tier 1 has the highest correlation in Asian variable of 0.619.	Tier 1 has the highest correlation with western location.

The correlation between the total criteria with two locations brings out some useful insights. It is observed that there is a higher correlation between total criteria with large eastern companies (P=0.627) rather than large western companies (P=0.447). Thus hypothesis H2, the sustainable criteria is expected to be more comprehensive and stringent in large western companies, is not strongly supported by the data. Thus, the study confirms that there is no notable difference between two locations with respect to sustainable procurement criteria for large enterprises.

5. Conclusion

The results support two theoretical perspectives that could be incorporated into the sustainable supplier selection process. Stakeholder theory and a dynamic capabilities view (RBV theory) are the two theories, that suit best for predicting sustainability performance of supply chain tiers and geographic locations for large enterprises. It is interesting to see that the supply chain tiers tend to follow sustainability practices while close to the end-customer. It can be deduced that the external pressure from the customers generates impact on large companies to ensure that sustainable business practices are adhered to. The hierarchical multiple regression analysis shows that the geographic location only contributes 42% predictive power for the total variation in sustainable business practices across large companies. Table 7 identifies that both geographic locations have an insignificant predictive probability to the total regression model. Furthermore, highest correlation between the two locations confirms that they have very similar sustainable procurement criteria for large enterprises. These findings support Pagell et al.'s (2010) postulation that sustainability will become expected normality in the future. Companies gain a competitive advantage by adopting sound sustainability practices (Paulraj, 2011), and this is evident through three important selection criteria identified through the data analysis. Environmental regulations, green purchasing and sustainable product quality, are driving criteria for sustainable supplier selection. Large companies can take a first mover advantage to act against the risk of poor practices being exposed promptly. The results suggest that in most instances this has already happened and now global companies are concentrating on maintaining sustainable objectives.

5.1. Theoretical and managerial implications

The research identifies the notable trends in the sustainable procurement criteria across different supply chain tiers for large enterprises. These findings are expected to support the identification of the weaknesses in the global supply chain network. The insights on trends in sustainability are useful for supply chain managers in making appropriate decisions related to supplier selection, supplier development and contract management, especially while dealing with large enterprises. For production systems, the insights will encourage managers to demand transparency across the supply chain tiers. Information regarding sustainable practices beyond first-tier suppliers is currently lacking. The research highlights the evident need for transparency to enhance sustainable procurement. The findings provide procurement managers with useful insights into the global supply base of large enterprises. The research is also

expected to support managers in making strategic procurement decisions such as in-sourcing or outsourcing, using long-term or sustainable suppliers, etc. It also identifies that large western companies operating globally have similar procurement criteria to large eastern companies. However, more attention may be required for small size companies, who are based in eastern regions, that act as contractors for the large global companies and do not have a global presence or brand image.

The deductive approach provides some useful theoretical contributions to the research. Sustainable procurement relationship is studied following two theoretical lenses, enhancing the link between stakeholder theory/dynamic capabilities view with a sustainability dimension. The research contributes to the theory by validating the advancement and suitability of stakeholder and RBV (dynamic capabilities view) theory for sustainability. The application of theoretical lenses for a practical and challenging supply chain network problem is believed to be a step forward in the advancement of supply chain management research. The insights developed are expected to provide building blocks for the development of a framework for sustainable procurement in the future. The research also contributes to the research methodology by analysing influential variables for sustainable procurement. The developed hypotheses are tested following a new and suitable methodological approach. Ghadimi et al. (2016), conducting a review of relationships in sustainable procurement, identify the need for models to calculate intangible influencing factors related to sustainability. The research contributes towards closing this apparent gap by testing different influential variables for supplier selection in the procurement function for large companies.

5.2. Limitations and future research directions

The research findings demand an extensive examination of the sustainable procurement criteria specified in the different tiers and global location. The results are based on the selected 83 large companies analysed in this study. It is important to note that the analysis is specific to the selected sample and that more comprehensive data will deliver better results. In the future, the sample size of the companies could be increased incorporating much broader scope of industry sectors to achieve comprehensive results. Also, the selected companies were large-sized manufacturing and technology firms with a global presence. A similar study including SMEs is expected to provide comprehensive results for the global supply chains. It is also expected that the results may vary depending on the size of companies (small, medium or large

enterprises) and the industry sector. Micro-level comparative studies based on size and industry sector are necessary to build holistic inferences on sustainability performance across supply chain networks.

Advanced research methods such as multi-criteria decision modelling supported with sensitivity analysis can provide robust results. For a holistic understanding of variables influencing sustainable procurement, systems thinking approach could have potential as a suitable research methodology. Despite a careful selection process of choosing/requesting most recent documents, some of the sustainability-related information provided by companies may be dated. Despite companies promoting their sustainable practices in large company reports, there could be a significant deviation between what they claim and what they do. Regarding the theoretical lenses, several other theories have a potential link to the sustainability performance and could have been used for the development of hypotheses. Signalling theory and brand equity theory can be included to develop further insights. The economic dimension within '*triple bottom line'* of sustainability had limited information, leading to the lack of insight regarding the importance of this dimension for sustainable procurement. However, it is understood that economic dimension is equally important compared to the other two dimensions in sustainability. The difference in the sustainability performance between tier 2 and tier 3 needs further study, as they form a core supply base for global organisations. Micro-level, comparative analysis of global multi-tier supply chain networks will pave the way for future research in sustainability performance measurement and management.

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